Resolution and accuracy of distribution maps

Use of a GIS allowed detailed mapping of bird locations and density distributions. Maps displaying geographic locations of birds as individual points provided basic distribution information but had limited ability to indicate relative density because no interpolation between transects occurred. The conversion of point data to density values and creation of density isopleths provided a detailed picture of bird density distribution. Advantages of mapping with the GIS over previous mapping by hand were automation, subjectivity reduction and resolution enhancement.

The accuracy of density isopleths depended on the distance between transects and bird location accuracy. Resolution increased with increased number of transects. The two parameters used to convert numbers of birds into average density values, length of block for calculating average density values and interval along transect that densities are calculated, also affected accuracy. Transects spaced every 7.4 km provided reasonable resolution for the distributions but took 4 years to accomplish with one aircraft. However smaller geographic features, such as Kigigak Island, were not sampled. Survey transects sampled only a small portion of the island, consequently the isopleth maps showed little or no bird presence. However, high densities of nesting eiders, cackling Canada geese and emperor geese have been documented by the more intensive coastal zone survey (Butler 1988) and ground studies on the island (Stehn 1991).

Data combined from different transects over several years may affect the resulting isopleth maps if population size is not relatively constant from year to year. For most of the major species, trend graphs showed relatively stable populations. Thus, we feel that combined years data from different transects provided the best distribution maps.

Waterbird distribution

Waterbirds were widespread throughout the survey area. The coastal zone between the Askinuk Mountains and Nelson Island contained the highest densities over the largest areas for combined duck species (Fig. 6). Higher densities of ducks were also observed near the mouths of the Yukon and Kuskokwim rivers.

Whereas densities of dabbling ducks tended to be highest nearer the coast, diving ducks and sea ducks were more abundant inland. High densities of scaup and scoters occurred in the area with numerous large lakes extending north and south of Baird Inlet (Figs. 8 and 9). Concentrations of ducks were observed on or near other lakes such as Nunavakanuk Lake north of Kusilvak Mountain, Portage Lakes near the east central YDNWR boundary, and Kayigyalik and Takslesluk lakes in the south-central portion of YDNWR.

Geese distributions in the coastal zone as determined by the expanded breeding population survey coincided closely with known distributions from the coastal zone survey. Canada and white-fronted geese occurred in low density and were aggregated in the interior of YDNWR (Appendices 13 and 15). Mallard, green-winged teal, and wigeon were also aggregated. Pintails were widespread but concentrated along coast. Shovelers converged along the Yukon River and at its mouths and at the mouth of the Kuskokwim River. Oldsquaw seemed to prefer the west-central portion of YDNWR. Black scoters occurred in low densities along the coast and higher densities > 20 km from the coast. The area to the southwest of, and including, Portage Lakes also contained higher densities of scoters.

Waterbird distribution was related to broad-scale habitat features. We considered areas with higher densities of ducks as being better quality habitat and areas with lower densities having poor or little habitat. Distribution maps displayed upland areas such as the Ungulungwak and Ingrichuak hills, with few water bodies, as having low densities of ducks. Observations of flocked birds aggregated on large lakes resulted in high density polygons associated with the lakes. King (1973) reported importance of Takslesluk Lake, about 66 km northwest of Bethel, as a molting lake for thousands of ducks. Maps for canvasback and scaup showed occurrence of these species in the Takslesluk Lake area during the breeding season also.

Landsat satellite imagery has been used to map broad vegetation classes on YDNWR (USFWS 1988). Although resolution of the classification was low, isopleths for combined duck species roughly corresponded to the distribution of the graminoid marsh class. Isopleths for combined duck species near the Yukon River Delta also reflected habitat zonation (Thorsteinson et al. 1989). The highest densities occurred in the tidally-influenced meadows and diminished inland as the habitat changed from grass-sedge meadows to grass-dwarf shrub transition areas. Establishing correlations of density classes with habitat types would allow development of other methods to increase precision of surveys and identification of high quality, but presently unoccupied, habitat.

<u>Future survey design</u>

Precision, bias and trend detection are 3 related but somewhat different measures for comparisons between survey designs. An analysis comparing precision, bias and trend detection for all current survey designs should be done. The expanded survey design probably has greater precision than the historic NAWBPS because of the increase in sample size from 8 transects to 15-17. However, the NAWBPS data and data from this survey could be analyzed using segments rather than transects as the sampling units. Re-analysis of existing data with new species-specific stratification boundaries would add to the value of further data analysis. Combining information from this analysis with density distribution information should allow creation of a new stratified survey design for future monitoring of breeding waterbird populations on YDNWR.

Density isopleths can be used to design future surveys. Density isopleth maps showed distribution for ducks was aggregated. However, size of aggregations was variable and is an important consideration for stratification. Only in certain areas, such as the coastal zone between the Askinuk Mountains and Nelson Island, did isopleths of high densities occur over a relatively large expanse. Using density isopleths to define strata and optimally allocate sampling effort in future surveys depends on the continuity and extent of the areas defined by the isopleths. For species such as mallard and wigeon, the maps indicated that stratification and transect adjustment based on bird density distribution would be impractical because of the small aggregations of birds scattered throughout YDNWR (Appendices 2 and 5).

Nevertheless, the precision of annual population indices for these species may be improved by complex stratification designs provided that the aggregate distribution is geographically constant over years. Stratification and adjustment of sampling effort is possible using the isopleths for other species or combined species groups. A balanced approach of broad stratification with greater sampling intensity in some strata as well as species-specific stratification in others would probably improve precision of indices for all species. The data collection and GIS procedures allow unprecedented opportunity for these statistical analyses.

SUMMARY AND RECOMMENDATIONS

An expanded breeding population survey to estimate abundance and delineate distribution of waterbirds was conducted in June 1989-1992 on Yukon Delta National Wildlife Refuge, Alaska. Several technological advances contributed to the design, implementation and analysis of the survey. The Division of Migratory Bird Management-Anchorage in cooperation with the Alaska Fish and Wildlife Research Center developed a computerized geographic information system (GIS) for mapping animal distribution and density. True BASIC and ARC/INFO computer programs generated and mapped survey transects. A LORAN-C or global positioning system was used in conjunction with transect maps for accurate navigation during surveys. Accurate geographic coordinates of observed birds were obtained by recording observations on continuously running cassette tapes (Butler et al. in prep A). Bird locations and numbers were converted to densities using a True BASIC program and maps of bird density isopleths were created using PC TIN, a 3-dimensional terrain modelling software package (Butler et al. in prep B).

Programs were developed that allowed calculation of population indices on subsets of the survey area. Use of this system and design resulted in increased precision in population indices, greater resolution in density distribution maps, and calculation of population indices on federal versus non-federal land. Waterbird densities and population indices can be calculated for any portion of YDNWR within defined political or biological boundaries (e.g. Native lands, habitat zones, watersheds). Annual distribution maps would allow detection of degree and rates of change in abundance and distribution of species.

Accurate waterbird abundance and distribution information over large geographic areas provides baseline information for management decision-making. The information can be used for land acquisition planning, mitigation planning, permit reviews, harvest regulation, identification of unique ecological areas, etc. For example, waterfowl density maps for the Yukon Delta and Yukon Flats National Wildlife refuges have been incorporated into the Division of Realty Acquisition Priority System model for ranking private lands within refuges for acquisition.

Three aerial survey designs have been used for various objectives on YDNWR. Analyses should be conducted to compare the results from the three designs. This information is important for developing future survey designs to meet specific objectives.

YDNWR is second only to Alaska's arctic coastal plain in amount of wetlands in Alaska. The remaining wetland areas in Alaska that have not been intensively surveyed are much smaller. An individual area could thus be sampled in one year, given adequate time, personnel and aircraft availability, at sufficient intensity for detailed distribution mapping. Use of this system over a period of years could provide a detailed map of waterbird density distributions throughout Alaska.

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